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Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **Five** questions in all.
3. Question Number **1** is compulsory.

1. Attempt any **five** of the following :   (3×5)

    (a) Find coordination number and packing fraction for fcc lattice.

    (b) Show that five-fold symmetry is not possible in a crystal.

    (c) Explain the fact that (100) reflection line does not vanish for CsCl, having bcc structure.

    (d) Prove that the number of normal modes of vibration in monoatomic lattice of finite length is equal to number of atoms in the lattice.

    (e) How does total polarizability depend on frequency ?

    (f) What are ferrites ? Why are they considered technically important solids ?

    (g) Discuss P-E hysteresis Loop of ferro-electric materials. What is its significance ?

    (h) What do you understand by Cooper pairs ?

2. (a) Describe the scheme to determine the Miller indices of a plane. Show the following planes in simple cubic lattice (111), (120), (020).

(b) Derive an expression for interplanar spacing between nearest planes (hkl) in a cubic crystal of side 'a'.

(c) Discuss Ewald construction and deduce Bragg's law in vector form.

(4,5,6)

3. (a) What are Phonons ?

(b) Derive dispersion relation for monoatomic chain. How it is different from continuous string ?

(c) Discuss the variation of group and phase velocity in First Brillouin Zone.

(2,8,5)

4. (a) State the assumptions made in Debye's theory of specific heat of solids.

(b) Derive a formula for Debye's T^3 law for molar heat capacity of solids.

(c) Compare Debye and Einstein model to explain the low temperature behaviour of lattice heat capacity.

(2,10,3)

5. (a) Obtain an expression for diamagnetic susceptibility using Langevin's theory. What is the significance of negative susceptibility ?

(b) Discuss the physical origin of domains in ferro-magnetic materials.   (10,5)

6. (a) What is electronic polarizability ?

(b) Derive an expression for the electronic polarizability in a varying field.

(c) Obtain an expression for complex dielectric constant. What is its significance ?

(2,6,7)

7. (a) Discuss Meissner effect and distinguish between Type I and Type II superconductor.

(b) Determine the critical field required to destroy superconductivity at 5K in Pb whose T_c is 7.19K and $H_c(0) = 0.0803$ T.

(c) Discuss piezo and pyroelectric effects. Give examples.

(6,3,6)

(2300)